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(54) **Method of producing a cooling liner**

Verfahren zur Herstellung eines Kühleinsatzes

Procédé de fabrication d'un insert de refroidissement

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Description

[0001] The present invention relates to the manufacture of an artefact comprising a liner which is intended to reside in spaced relationship within a hollow aerofoil.

[0002] More particularly, the invention relates to the manufacture of a liner which is required to reside in said spaced relationship within a hollow aerofoil, the interior of which is so shaped as to preclude inserting the liner therein, when the liner has its operational shape.

[0003] The invention has particular efficacy, where the liner is multi-perforated, and is intended to fit within the hollow interior of a guide vane which has opposing ends of radically differing profiles, and is utilised in a gas turbine engine. The liner is fitted for the purpose of enabling an impingement cooling airflow onto the interior surface of the guide vane during operation thereof in an associated said gas turbine engine.

[0004] US-A-5 516 260 discloses a hollow vane for a gas turbine engine enclosing a liner which is so shaped as to include at least one integral spring that serves to urge the liner into engagement with the inner surface of the vane. US-A-4 413 949 discloses a hollow turbine blade having two adjacent liners positioned within its interior. One of the inserts is of generally C-shaped cross-sectional shape, formed from a resilient material and is maintained in compression so as to ensure firm positioning of both inserts within the blade. In both cases, the specific shaping of each insert is maintained within its associated vane or blade in order to ensure its ongoing resilience.

[0005] According to the present invention, a method of manufacturing and fitting a hollow liner within a hollow aerofoil which has respective open ends of differing proportions, comprising the steps of producing said hollow liner and crimping a portion thereof so as to enable said liner to be fitted into said hollow aerofoil, then fitting said liner into said hollow structure and subsequently stretching said liner so as to substantially obviate said crimping and form said liner to its desired final shape within said hollow aerofoil.

[0006] The invention will now be described, by way of example, and with reference to the accompanying drawings, in which:

Fig 1 is a pictorial representation of a gas turbine engine guide vane, which includes a perforated impingement cooling liner in accordance with the present invention.

Fig 2 is a developed view of the liner of Fig 1, prior to perforation, and:

Fig 3 is a view on Fig 2 in the direction of arrow 3.

Figs 4 to 6 depict alternative crimp forms.

Fig 7 depicts an alternative mode of manufacturing an impingement cooling liner in accordance with the present invention.

Fig 8 depicts an impingement cooling liner crimped in accordance with the present invention.

[0007] Referring to Fig 1, a hollow guide vane 10 has a number of ribs 12 formed on its inner wall surface, which extend the full length of the vane 10, though only one rib 12 is thus shown. The ribs 12 locate a perforated liner 14 in spaced relationship with the inner wall surface of the vane 10.

[0008] The guide vane 10 is formed in the configuration of an aerofoil. However, in view of the greater understanding of aerodynamic flows which today's designers possess, accompanied by the ever increasing demand to achieve higher engine efficiency, the overall shape of guide vanes has changed dramatically, resulting in profiles, the proportions of which change radically from one end of the vane to the other end thereof, as in guide vane 10. As is seen in Fig 1, the relative chordal dimensions A at the end extremities of vane 10 are approximately 2: 1. However, the relative width dimensions are approximately 1:2. It would thus be impossible to insert a liner 14 of corresponding shape in either end of vane 10.

[0009] Referring now to Fig 2, liner 14 is first produced as a developed shape of the finished article, which shape, in the present example, defines an actual or near trapezoid 16. The trapezoid 16 is then crimped a sufficient number of times, on both sides of datum line 20, (though crimps 22 are only shown on one side thereof), so as to draw each end portion thereof towards datum line 20, and thus shortens it.

[0010] The number of crimps 22, and their proportions, as shown in Fig 2 and Fig 3 are merely illustrative. Their actual proportions and numbers will be dictated by the proportions of the vane 10 in which the liner 14 is to be fitted. Thus, in the present example, Fig 2 depicts six crimps 22 extending from edge 18 to edge 24. The pitch of the crimps 22, multiplied by the number thereof, equals the dimension B (Fig 3), which is repeated on the opposing side of datum line 20.

[0011] After crimping, the trapezoid 16 is folded about datum line 20, to bring edges 26 and 28 together, and the resulting liner 14 inserted into the vane 10, via its wider, shorter end. Thereafter, a forming tool (not shown) is inserted in liner 14, and a force applied thereon in a direction chordally of the liner 14 and vane 10, so as to expand liner 14 by straightening the crimps 22.

[0012] An alternative mode of reforming line 14 may be utilised, and consists of filling it with an elastomeric material, which is then pressurised and thus causes liner 14 to expand.

[0013] The crimps 22 shown in Fig 2 are of inverted V shape and stand proud of one side only of trapezoid 16. however, as depicted in Fig 4, crimps 22 could be formed so as to alternately protrude from both sides thereof.

[0014] Fig 5 depicts another alternative, wherein the crimps 22 are corrugated in serpentine manner, and protrude from one side only. However, the serpentine corrugations could, if so desired, protrude alternately from both sides, as shown in Fig 6.

[0015] A further method of manufacturing liner 14, is by deforming a frusto-conical tube 30 (Fig 7) of circular

cross section into the finished desired shape, and then, as shown in Fig 8, crimping the side walls thereof over at least a major portion of its length. The crimps 34 are tapered, being their widest at that end of the tube 30 which defines the longest chordal dimension. A sufficient number of crimps, of appropriate proportions, are formed so as to draw the long ends of the liner together, to allow insertion of the tube 30 into the smaller end of the vane 10 (Fig 1). Stretching of the liner tube 30 can be effected as described hereinbefore, with respect to Figs 1 to 3.

Claims

1. A method of manufacturing and fitting a hollow liner (14) within a hollow aerofoil (10) which has respective open ends of differing proportions, said method comprising the steps of producing said hollow liner (14) and crimping a portion thereof so as to enable said liner (14) to be fitted into said hollow aerofoil (10), fitting said liner (14) into said hollow aerofoil (10), **characterised in that** said liner (14) is subsequently stretched so as to substantially obviate said crimping (22) and form said liner (14) to its desired final shape within said hollow aerofoil (10).

2. A method of manufacturing and fitting a hollow liner (14) as claimed in claim 1 **characterised in that** said method includes the steps of producing the liner (14) as a developed plane form, crimping the plane form to shorten it, folding the plane form to join opposing ends thereof, and then inserting the resulting liner (14) in the hollow aerofoil (10) and stretching it to substantially obviate said crimps (22) and form said liner (14) into its final desired shape within said hollow aerofoil (10).

3. A method of manufacturing and fitting a hollow liner (14) within a hollow aerofoil (10) as claimed in claim 1 **characterised in that** said method comprises the steps of forming a frusto-conical tube (30) of circular cross section, each end of which has a peripheral length equal to the peripheral length of a respective end of said hollow aerofoil (10), deforming said tube (30) to the final desired shape of said liner (14), crimping the end thereof having the greater peripheral length, so as to effectively shorten it, inserting it **in that** end of the hollow aerofoil (10) having the smaller periphery, then stretching said liner (14) to substantially obviate said crimps (22) and form said liner (14) into its final desired shape within said hollow aerofoil (10).

4. A method of manufacturing and fitting a hollow liner (14) into a hollow aerofoil (10) as claimed in any previous claim, **characterised in that** said crimps (22) define a series of ridges.

5. A method of manufacturing and fitting a hollow liner (14) into a hollow aerofoil (10) as claimed in any of claims 1 to 3, **characterised in that** said crimps (22) define a series of sinusoidal corrugations.

6. A method of manufacturing and fitting a hollow liner (14) into a hollow aerofoil (10) as claimed in any previous claim **characterised in that** said crimps are formed on only one side of the material from which said liner (14) is manufactured.

7. A method of manufacturing and fitting a hollow liner (14) into a hollow aerofoil (10) as claimed in any of claims 1 to 5 **characterised in that** said crimps (22) are formed on both sides of the material from which said liner (14) is manufactured.

8. A method of manufacturing and fitting a hollow liner (14) into a hollow aerofoil (10) as claimed in any previous claim, **characterised in that** said hollow aerofoil is a gas turbine engine guide vane.

Patentansprüche

1. Verfahren zur Herstellung und zum Einsatz einer hohlen Auskleidung (14) in einem hohlen Stromlinienkörper (10), dessen offene Enden unterschiedliche Größenverhältnisse aufweisen, wobei das Verfahren die folgenden Schritte umfasst: es wird die hohle Auskleidung (14) hergestellt, und ein Teil hiervon wird derart gefaltet, dass die Auskleidung (14) in den hohlen Stromlinienkörper (10) einsetzbar wird, und es wird die Auskleidung (14) in den Stromlinienkörper (10) eingesetzt,
dadurch gekennzeichnet, dass die Auskleidung (14) danach derart ausgebreitet wird, dass die Faltung (22) im Wesentlichen beseitigt wird und die Auskleidung (14) in ihre gewünschte Endform innerhalb des Stromlinienkörpers (10) gebracht wird.

2. Verfahren zur Herstellung und zum Einsatz einer hohlen Auskleidung (14) nach Anspruch 1,
dadurch gekennzeichnet, dass das Verfahren die folgenden Schritte umfasst: es wird die Auskleidung (14) in abgewickelter ebener Form erzeugt; es wird die ebene Form gefaltet, um sie zu verkürzen; es wird die ebene Form gefaltet, um die gegenüberliegenden Seiten hiervon zu verbinden; und dann wird die sich ergebende Auskleidung (14) in den hohlen Stromlinienkörper (10) eingesetzt und ausgebreitet, so dass die Faltungen (22) im Wesentlichen beseitigt werden und die innere Auskleidung (14) in ihre endgültige gewünschte Form innerhalb des Stromlinienkörpers (10) gebracht wird.

3. Verfahren zur Herstellung und zum Einsatz einer hohlen Auskleidung (14) in einem hohlen Stromlini-

enkörper (10) nach Anspruch 1,
dadurch gekennzeichnet, dass das Verfahren die folgenden Schritte umfasst: es wird ein kegelstrumpfförmiges Rohr (30) kreisförmigen Querschnitts erzeugt, wobei die beiden Enden eine Umfangslänge besitzen, die gleich ist der Umfangslänge des jeweiligen Endes des hohlen Stromlinienkörpers (10); es wird das Rohr (30) auf die endgültige gewünschte Form der Auskleidung (14) gebracht; es werden die Enden des Rohres mit der größeren Umfangslänge derart gefaltet, dass eine wirksame Kürzung eintritt; es wird das Rohr in jenes Ende des hohlen Stromlinienkörpers (10) eingesetzt, das den kleineren Umfang besitzt; und es wird dann die Auskleidung (14) ausgebreitet, um die Faltungen (22) im Wesentlichen zu entfernen und die Auskleidung (14) in der endgültig gewünschten Form innerhalb des hohlen Stromlinienkörpers (10) zu erzeugen.

4. Verfahren zur Herstellung und zum Einsatz einer hohlen Auskleidung (14) in einen hohlen Stromlinienkörper (10) nach einem der vorhergehenden Ansprüche,
dadurch gekennzeichnet, dass die Faltungen (22) eine Reihe von Rippen aufweisen.

5. Verfahren zur Herstellung und zum Einsatz einer hohlen Auskleidung (14) in einen hohlen Stromlinienkörper (10) nach einem der Ansprüche 1 bis 3,
dadurch gekennzeichnet, dass die Faltungen (22) eine Reihe von sinusförmigen Wellungen bilden.

6. Verfahren zur Herstellung und zum Einsatz einer hohlen Auskleidung (14) in einen hohlen Stromlinienkörper (10) nach einem der vorhergehenden Ansprüche,
dadurch gekennzeichnet, dass die Faltungen nur auf einer Seite des Materials ausgebildet sind, aus dem die Auskleidung (14) hergestellt ist.

7. Verfahren zur Herstellung und zum Einsatz einer hohlen Auskleidung (14) in einen hohlen Stromlinienkörper (10) nach einem der Ansprüche 1 bis 5,
dadurch gekennzeichnet, dass die Faltungen (22) auf beiden Seiten des Materials ausgebildet sind, aus dem die Auskleidung (14) hergestellt ist.

8. Verfahren zur Herstellung und zum Einsatz einer hohlen Auskleidung (14) in einen hohlen Stromlinienkörper (10) nach einem der vorhergehenden Ansprüche,
dadurch gekennzeichnet, dass der hohle Stromlinienkörper die Leitschaufel eines Gasturbinentriebwerks ist.

Revendications

1. Procédé de fabrication et d'ajustement d'une doublure creuse (14) à l'intérieur d'un profil aérodynamique creux (10) qui a des extrémités respectives ouvertes de proportions différentes, ledit procédé comprenant les étapes consistant à produire ladite doublure creuse (14) et gaufrer une portion de celle-ci afin de permettre à ladite doublure (14) d'être ajustée dans ledit profil aérodynamique creux (10), ajuster ladite doublure (14) dans ledit profil aérodynamique creux (10), **caractérisé en ce que** ladite doublure (14) est ultérieurement étirée afin de remédier sensiblement audit gaufrage (22) et former ladite doublure (14) selon sa forme finale souhaitée à l'intérieur dudit profil aérodynamique creux (10).

2. Procédé de fabrication et d'ajustement d'une doublure creuse (14) selon la revendication 1, **caractérisé en ce que** ledit procédé comporte les étapes consistant à produire la doublure (14) en tant qu'une mise en forme plane développée, gaufrer la mise en forme plane pour la raccourcir, plier la mise en forme plane pour joindre ses extrémités en opposition et insérer ensuite la doublure (14) résultante dans le profil aérodynamique creux (10) et l'étirer afin de remédier sensiblement auxdits gaufrages (22) et former ladite doublure (14) selon sa forme finale souhaitée à l'intérieur dudit profil aérodynamique creux (10).

3. Procédé de fabrication et d'ajustement d'une doublure creuse (14) à l'intérieur d'un profil aérodynamique creux (10) selon la revendication 1, **caractérisé en ce que** ledit procédé comprend les étapes consistant à former un tube tronconique (30) de section transversale circulaire, dont chaque extrémité a une longueur périphérique égale à la longueur périphérique d'une extrémité respective dudit profil aérodynamique creux (10), déformer ledit tube (30) à la forme finale souhaitée de ladite doublure (14), gaufrer son extrémité ayant la longueur périphérique plus grande, afin de la raccourcir de manière efficace, l'insérer dans le profil aérodynamique creux (10) ayant la périphérie plus petite, puis étirer ladite doublure (14) pour remédier sensiblement auxdits gaufrages (22) et former ladite doublure (14) dans sa forme finale souhaitée à l'intérieur dudit profil aérodynamique creux (10).

4. Procédé de fabrication et d'ajustement d'une doublure creuse (14) dans un profil aérodynamique creux (10) selon l'une quelconque des revendications précédentes **caractérisé en ce que** lesdits gaufrages (22) définissent une série de nervures.

5. Procédé de fabrication et d'ajustement d'une doublure creuse (14) dans un profil aérodynamique

creux (10) selon l'une quelconque des revendications 1 à 3, **caractérisé en ce que** lesdits gaufrages (22) définissent une série d'ondulations sinusoïdales.

6. Procédé de fabrication et d'ajustement d'une doublure creuse (14) dans un profil aérodynamique creux (10) selon l'une quelconque des revendications précédentes, **caractérisé en ce que** lesdits gaufrages sont formés uniquement d'un côté du matériau à partir duquel ladite doublure (14) est fabriquée.

7. Procédé de fabrication et d'ajustement d'une doublure creuse (14) dans un profil aérodynamique creux (10) selon l'une quelconque des revendications 1 à 5, **caractérisé en ce que** lesdits gaufrages (22) sont formés des deux côtés du matériau à partir duquel ladite doublure (14) est fabriquée.

8. Procédé de fabrication et d'ajustement d'une doublure creuse (14) dans un profil aérodynamique creux (10) selon l'une quelconque des revendications précédentes, **caractérisé en ce que** ledit profil aérodynamique creux est une aube de guidage de moteur à turbine à gaz.

Fig.1.

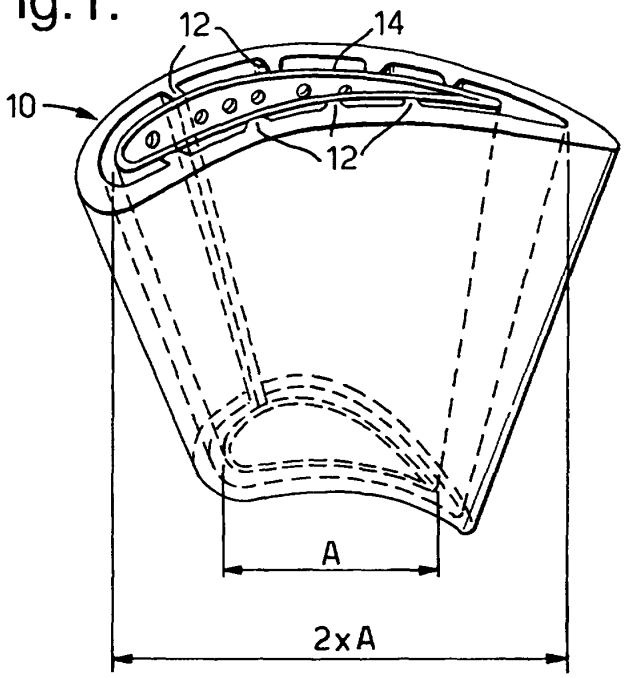


Fig.2.

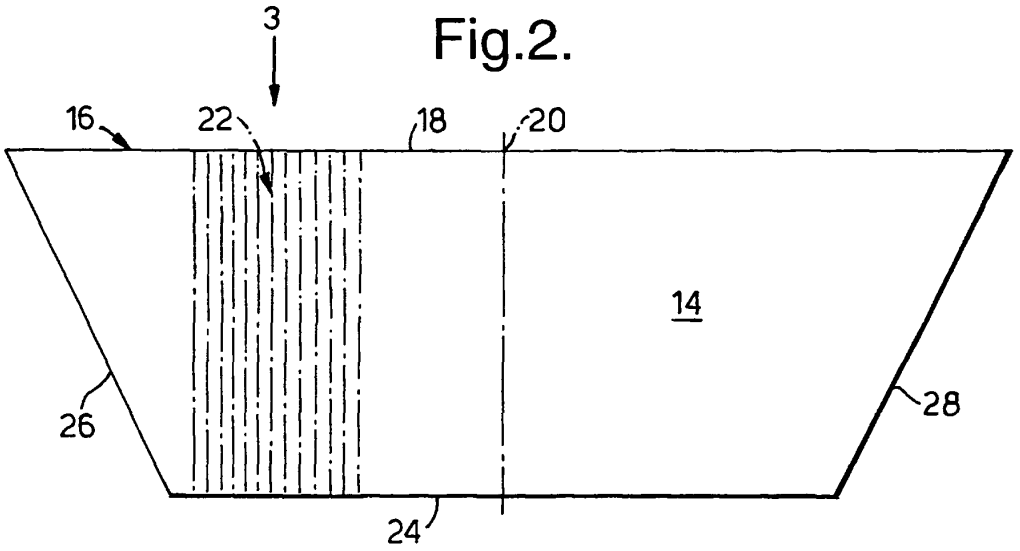


Fig.3.

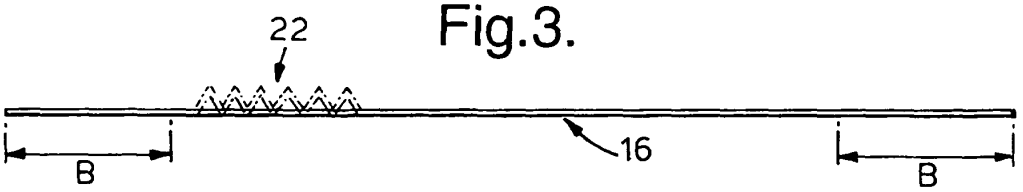


Fig.4.

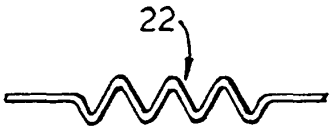


Fig.5.

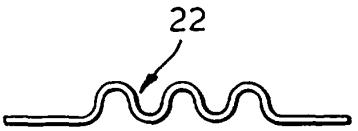


Fig.6.

Fig.7.

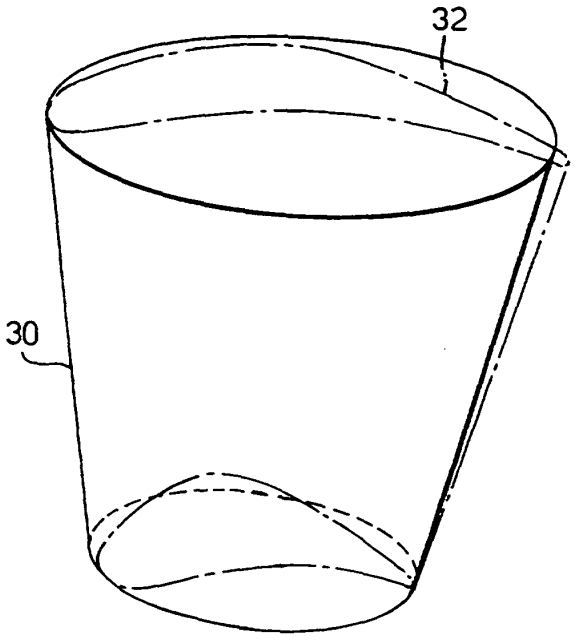
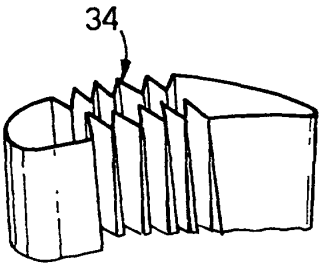


Fig.8.



REFERENCES CITED IN THE DESCRIPTION

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